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AUTHOR Malik, M. F.
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ABSTRACT

Some of the theories which have been developed to explain how visual space is actually perceived, processed, and stored in the human brain are briefly noted, and the correspondence of contemporary systems of stereocinematography and holography to the neural processes of the brain is explored. Major concepts discussed include projective geometry, three dimensional perception, space perception, human information channels, and segmented space systems. The comprehension of these concepts was the foundation for modern stereocinematography techniques. Segmented space systems are said to be similar to stereocinematography, where the viewer is confined to a certain area, viewing the angle and precise timing of the show so the psychodramatic information impact is decreased geometrically with the length of time. Holography is described as a typical example of the use of projective geometry, where the viewer is in the movable horizon or place so his/her own eyes are a vanishing point or camera, and with every movement of his/her eye or head the entire picture will change its projective geometry. (JEG)

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PSYCHOPHYSIOLOGY OF VISUAL SPACE IN FILM AND TELEVISION

Dr. M. F. Malik

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DR. M.F. MALIK

PSYCHOPHYSIOLOGY OF VISUAL SPACE IN FILM AND TELEVISION

Man is striving for centuries in the quest of capturing space in images. From cave painters to gothic and rennaisance masters to contemporary film and television makers. All have given care to the element of "space" in their images.

But how is this "visual space" actually perceived, processed and stored in the human brain? Sometimes, why do very different visual space cues, perspectives or positions of objects in an image create the feeling, or knowledge of the same distance and space? How do contemporary systems of stereocinematography or holography correspond to the neural processes of the human brain?

The human eye is often compared to the camera, but there is an enormous difference between the two: camera records the reality with all the details sometimes invisible to the human eye, but the eye interprets reality with the cooperation of the neural network, visual neocortex of the brain in a myriad of feedbacks. Many of them are changing the chemo-electrical impulses close to the input place. The light impinging on the receptors (the rods and the cones) gives rise to a continuous change in the structure of photosensitive molecules. The change in structure resleases a flow of ions in the receptor, culminating in a bioelectric signal that travels from the receptor into adjacent nerve cells. The strength of the signal varies with the light flux. Within a few miliseconds the myriad changes in a signal pattern over the entire retina are combined and transformed by an intricate neural network within the retina itself, by other networks at relay stations in the mid-brain and finally by the neural networks within a number of receiving terminals in the cerebral cortex. From there more "visual space" has connections with established neural pathways, carriers of cognitive and abstractive notions of "imaginatory"space.

The theory of the perception of visual space was outlined as long ago as 1709 by G. Berkeley, and further developed by Hermann von Helmholz in the 19th. century. Today we use part of this theory in the questions of "cues". According to this theory, the two dimensional image on the retina is visually interpreted as being three-dimensional by a number of cues or signs. The cues are available not only in the image itself, but also in the activity of the oculomotor apparatus, in the visual cortex and in the other cortical regions of the brain. The cues include binocular disparity in the images seen by the two eyes, convergence and accomodation of the lens, size of image, interposition of figures, binocular perspective and so on. The theory also invokes visual-motoric experiences and learning as important supplementary factors.

Berkeley only knew Euclidean geometry, and as a result he began his study of the relation between stimulus and a percept by analysing the retinal image as if it could be adequately measured with a ruler and a protractor. Even today many excellent optics stay within the tradition of measuring optical projections inmilimeters and degrees of arc. This approach has given rise to many artificial problems, such as trying to explain how retinal images of different sizes and forms can evoke perception of the same object.

New geometries that have come into existence since Berkeley's day and are free of the Euclidean parallel axiom, which leads to the postulate that parallel lines do not meet. We all know from experience looking at the highway, that parallel lines indeed meet in our percept. This is a clasical example of "projective geometry", or geometry using human vision feedback plus the record of optical paths as seen through lenses or pinholes. This geometry is nonmetric because it deals exclusively with relations rather than particular measurements.

Another theory came into space concepts in 1950. J.J. Gibson stated, that image itself contains all the information needed for the three-dimensional perception, and added the importance of "gradients" and "high-order variables".

In 1963 David H. Hubel was exploring the neural pathways in the visual cortex of the brain and explaining some aspects of space concepts and how we perceive and store them.

Adelbert Ames and Norman Haber led, in the past twenty years, an enquiry into the psychological questions of space perception and space concept.

In 1971 H.J. Hsia connected the Hubel and Ames findings to the biocybernetic model of human information channels, namely in the area of channell processing capacity and modality.

In contemporary times, research work concerning the psychophysiology of the picture space is carried on at the University of Uppsala, Cornell University, Research Institute in Milan (CIRSIV), MIT, Stanford and Concordia University of Montreal.

The early attempts to deliver or restore "space" for viewers by the use of "extended binocular vision" (stereoscopes, stereocinematography, stereotelevision) were actually optical extensions of visual space cues. Therefore, precise parameters of Euclidean geometry must be maintained in order to perceive true three-dimensional image. A pair of glasses, separating two images, or precise place in an auditorium of stereocinema theatre is a necessary carrier

of "space" modality of pictures. Every small movement of body, eyes or repositioning on the seat causes either complete loss of three-dimensionality, or major distortation of the image.

This limitation had small and negligible effect at times, where the 3D picture was an absolute novelty, or where scientific reason demanded the complete discipline of the viewer. But, it presents major obstacles in "natural" uninhibited viewing (similar to the watching of television, film or a simple look into the countryside.)

For most of the stereo-films and tv programs, the lack or non-correspondence of of space cues feedback was causing a low level of viewer participation, nearly 100% inhibition or development of psychodrama - all factors resulting in no success of the so proclaimed "new medium".

Some systems and inventors (Ivanov) were aware of this limitation, and searched for the solution where viewers have more freedom of body, head and eye movements. So far their systems are either very heavy, difficult to install and difficult to maintain in operation.

The stereo-way had fought the impossible fight: to give the human eye a substitute for 3D image, perfect in geometric and optical sense: - When the human brain was able to discover these substitutes in fractions of seconds, and when those non-correspondences were confirmed by a myriad of feedback, that related back to the brain. The resulting, permanent feedback "negatives" caused the viewer's loss of interest, fatigue and a high threshold level on brain neural nets.

Between 1940 and 1950 a small group of scientists in Czechoslovakia were attacking the same problem, but from a very different point of view. Ing. Brichta and Kubalek found that visual information, segmented in actual 3D space, could deliver a remarkable amount of high spacial, pictorial impact. They experimented first with images, positioned in different directions, sizes and definitions, in the entire exhibition hall completely covered by a dark cloth. They worked on the principles of "projective geometry". Early attempts were at first utilized in theatre designs and displays, and later realised as a series of systems, now known as "polyecrans", "polyvisions" and"diapolyecrans". Czechoslovac artists were able to fill the "segmented space" with themes, stories and their work is widely known over the world.

The basic advantage of "segmented space" is in the implication of real space, combined with a pictorial one, following the basic rules of projective geometry. This correspondence demands special treatment of images, their positioning and synchronisation within the system. Only rarely is the normal photographic or cinematographic image useable for a segmented space system without previous careful information design.

A Czechoslovacian school employed much more than spacial geometry - also the movement of images and screens, using the combination of live actors with 2D image and the high, vertical information cascades of pictorial information.

The disadvantage of segmented space systems is somehow similar to the the stereocinematography, the viewer is confined to a certain area, viewing the angle and precise timing of the show; therefore, the psychodramatic information impact is decreased geometrically with the length of time. It is known, that the best Czechoslovacian "segmented"shows were of a duration between 9 and 15 minutes. After that, fatigue or an overload of information was apparent to most of the audience.

When Upatniek realised Gabor's concept of holography in 1965, from the beginning of this discovery, one aspect was astonishing. Although the pictures were small and inacurate, the human brain was fighting furiously to find "non-corresponding" cues to discover the irreality of pictures. It did not find any, except for the tactile feedback, assuring the viewer, that the hologram is indeed a picture, and not a reality.

So, holography reigns in the system of 3D images, even if the technical feasibility and quality of pictorial representation is poor.

What is the neurophysiological base of the impact of holograms? Holography is a typical example of the use of projective geometry, where the viewer is in the moveable horizon or place, therefore the viewer's own eyes are a "vanishing point", or camera. The most striking impact of a hologram lies in the fact that with every viewers movement of eye or head makes the whole picture slightly change its projective geometry. The picture starts to be perceptually "attached" to the viewer's eye, demanding a high level of viewer's perceptual participation, feedback.

The consequences of such a perceptual reversal are astonishing: No longer is the "image" a carrier of the information impact itself, but acts as a powerful catalist. The information of space image exists mostly in the viewer's head - and pictorial representation could be strikingly simele when the information impact in the viewer's brain is big. The picture no longer demands a fast succession or richness in detail. As known from traditional film or television the opposite is true: less succession and a slower pace is more enjoyable to the audience for holographic space. Size has an enormous impact, especially when measured by the viewer's own size.

Holography also has its limitations, although they are out of the limit of the 3D phenomenon. Significant limitation is it's wholeness: it could be difficult to segment the picture formally or semiotically. Even a simple story told by a succession of holograms, may have notches in the structure. We may relate holography more to the work of theatre or architecture than to film and television as an information transmission medium.

One phenomenon of 3D film and television should still be explored. The imagined space, "meta-space", which does not exist or sporadically exists on the screen picture, but is working in the viewer's mind. When perceiving a picture, multiple recordings (EEG) are registered from the cerebral cortex. The pictures with an enhanced projective or descriptive geometry simultaneously receive neural input from the point within the cortical regions - from "inside" the brain. Usually electrodes that are attached to the right hemisphere of the brain yield more activity. We assume that by the interpretation of spacial cues of pictures, the right hemisphere of the brain is more active, but, when it comes to the cognitive aspects of spatial cues - "kind of spaces" - the left hemisphere of the brain shows more activity, especially when a demand on coding or verbal recall is high.

The feedback from "within" the brain is very fast - in the range of 3-5 milliseconds and is usually repeated many times. The visual cues of picture space are solved in neural nets before the signal goes into the cerebral cortex, but the cortical feedback always appearsif the picture is pseudoscopic or stereoscopic in nature.

It is also apparent that pictures with enhanced geometry leave certain "remains", namely in the right hemisphere of the brain. Those may serve as triggers for future recalls or retrievals of information. Occasionally, they may sensitise the neural networks to an easy development of stress waves, or an increase in the sensitivity of neuron circuits to the information inputs. Those "remains" are not stable, they decay with time as other codes do in long-term memory.

Finally there is the possibility of combining spacial cues without the external information input. Vivid spacial memories, dreams flow through, space occurs in person's life confirming that those concepts are results of an accidental or revoked neural combinations in human brain. But pressing for more detail or repeated occurences the brain will strive with difficulties to realise the "projective geometry of our mind."

Pictures:

1. Example of "projective geometry"
2. Trapezium concept
3. Perception of 3D space in 2D pictures
4. Human Information Processing Capacity

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